Sirius Vacuum System

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LNLS Vacuum Group

Diffraction Limited Storage Rings workshop – APS, Nov. 19th-21st, 2014.

Outline

- Storage ring
  - Vacuum system layout
  - Chambers and components design concept
  - Cleaning process and NEG coating
  - Chambers storage and installation
  - Bake-out for NEG activation
- Booster

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Storage ring: **Vacuum system layout**

Rafael Seraphim

Compact lattice and small aperture magnets

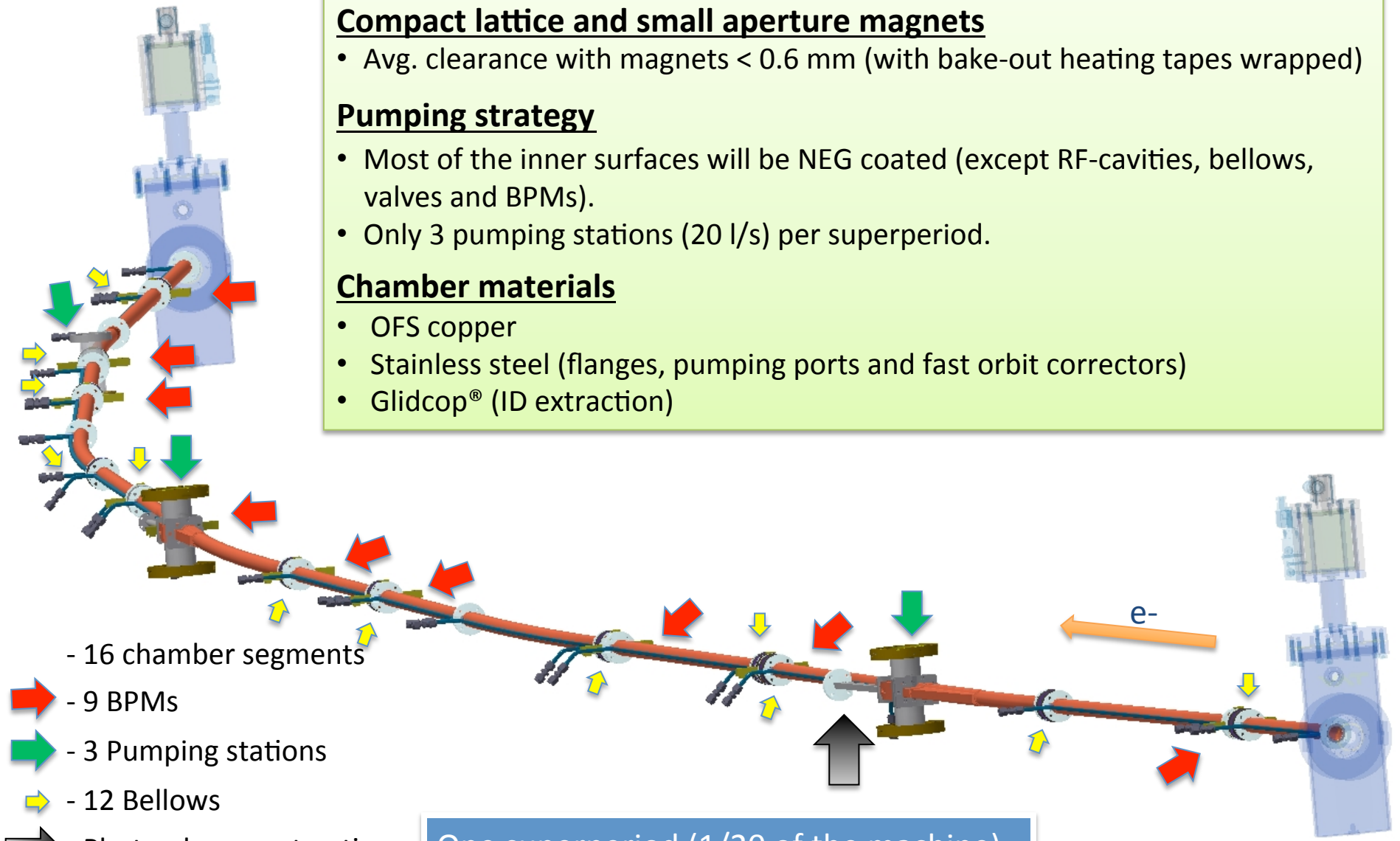
- Avg. clearance with magnets < 0.6 mm (with bake-out heating tapes wrapped)

Pumping strategy

- Most of the inner surfaces will be NEG coated (except RF-cavities, bellows, valves and BPMs).
- Only 3 pumping stations (20 l/s) per superperiod.

Chamber materials

- OFS copper
- Stainless steel (flanges, pumping ports and fast orbit correctors)
- Glidcop® (ID extraction)



One superperiod (1/20 of the machine)

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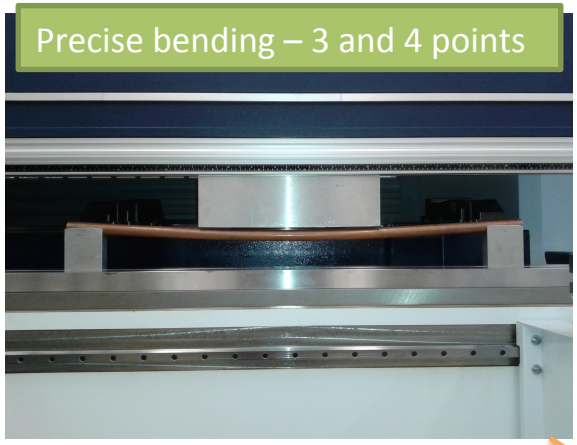
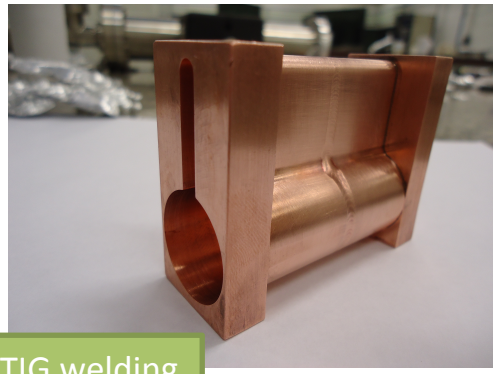
Storage ring: **Chambers and components design concept**





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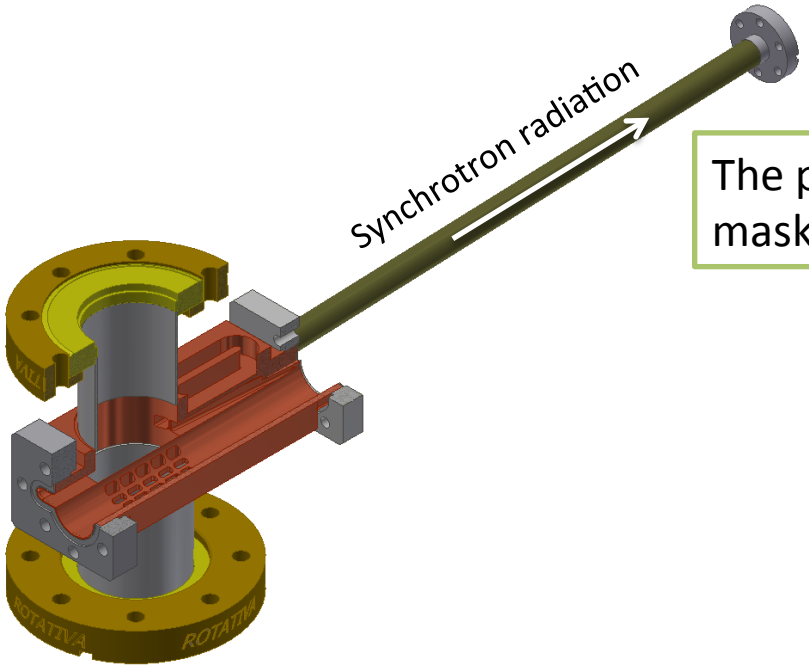
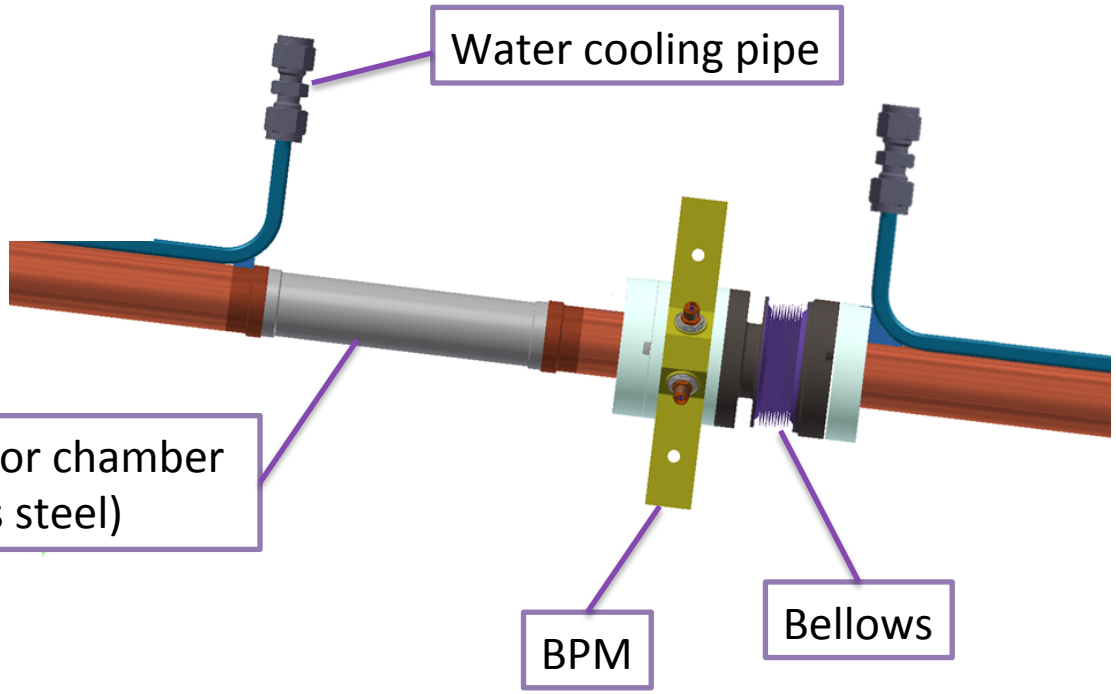
Storage ring: **Chambers and components design concept**



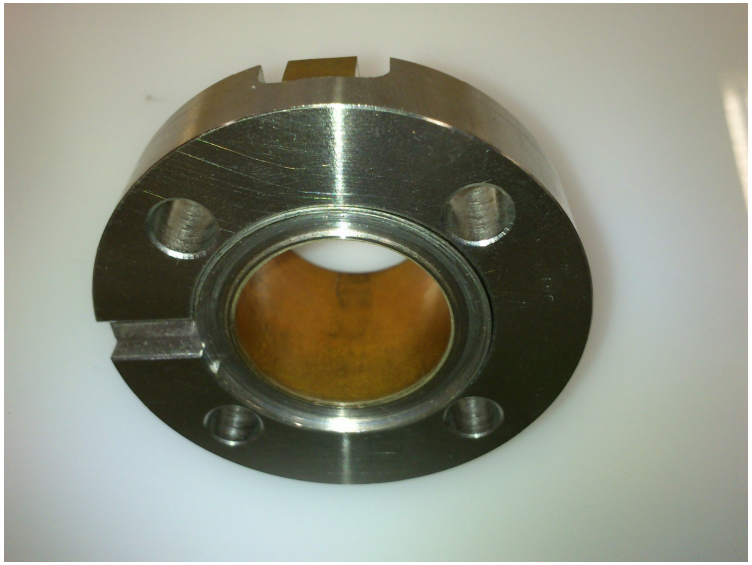
The pumping station includes a mask for synchrotron radiation.

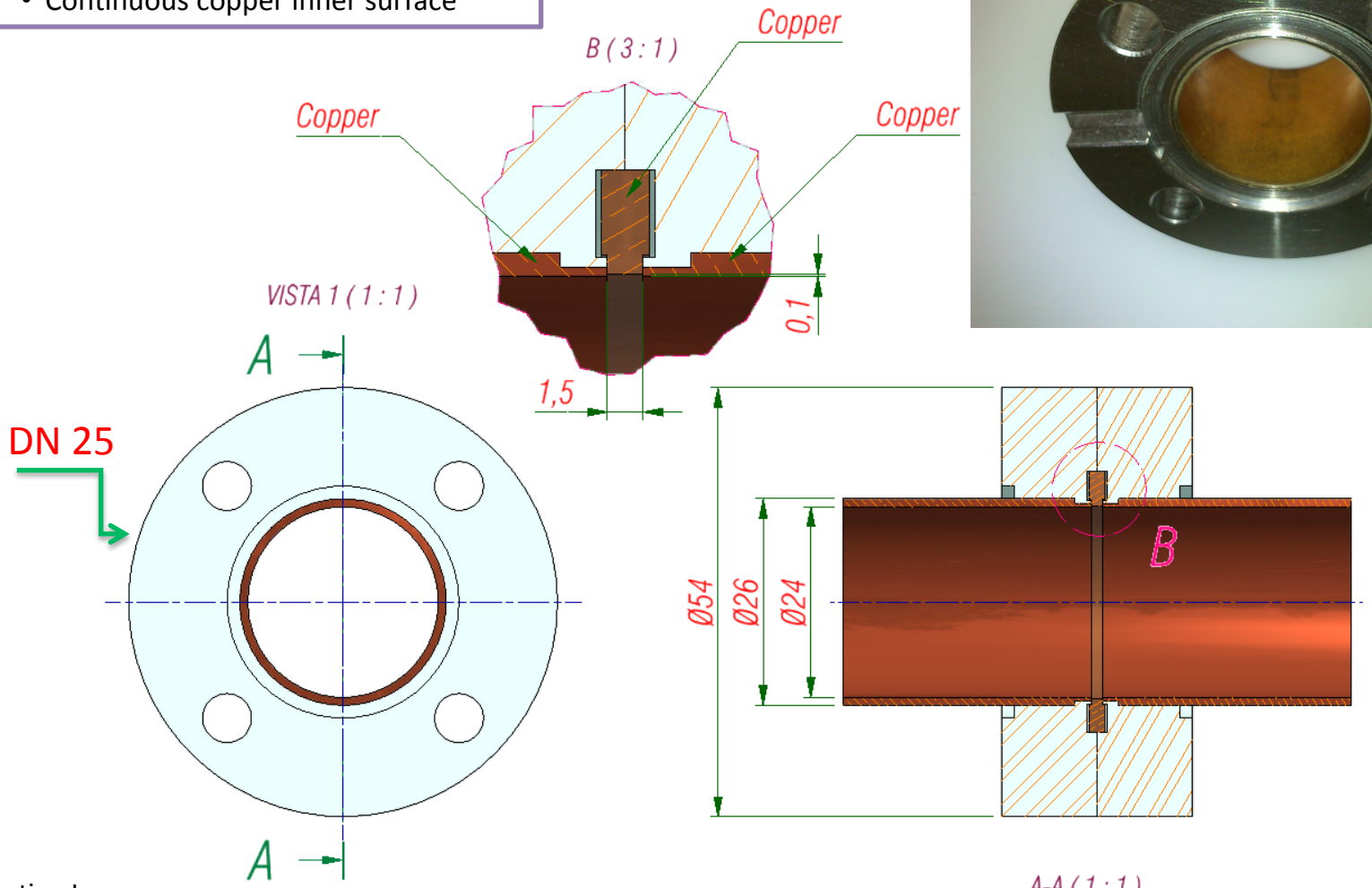


Storage ring: Chambers and components design concept

Modified KEK MO-type flange (circular and non-circular):

- No gap
- No step
- Continuous copper inner surface

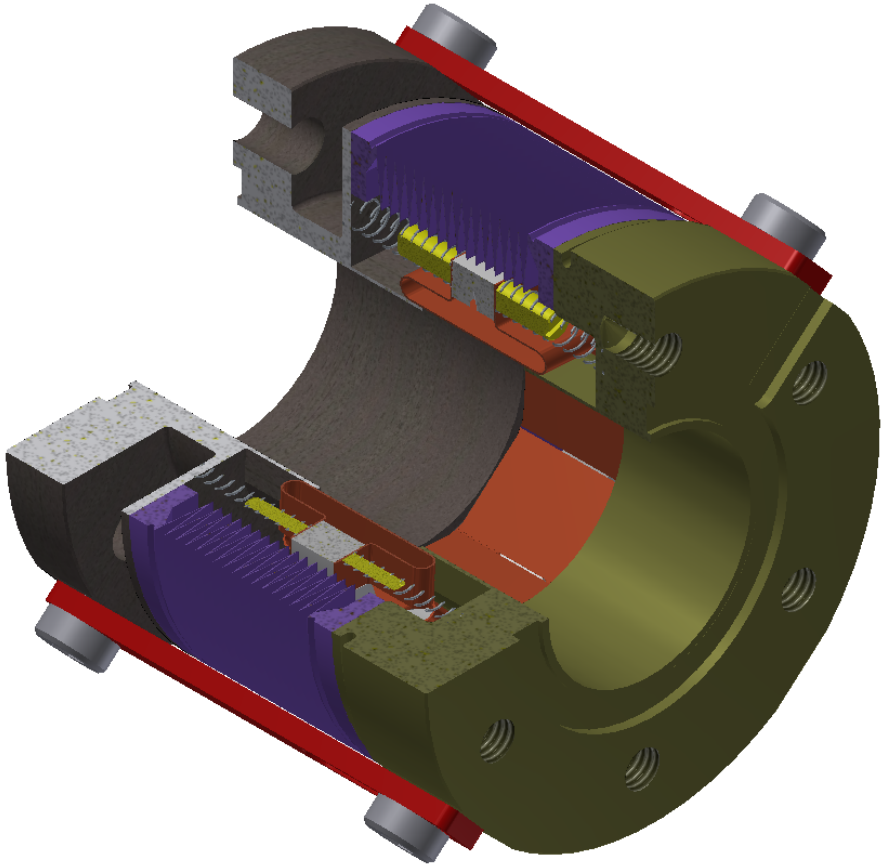


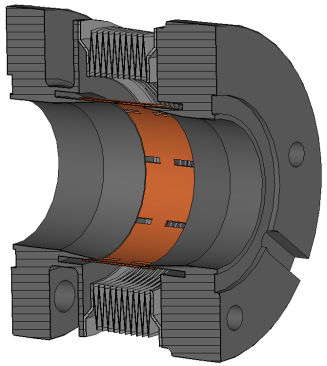


Storage ring: Chambers and components design concept

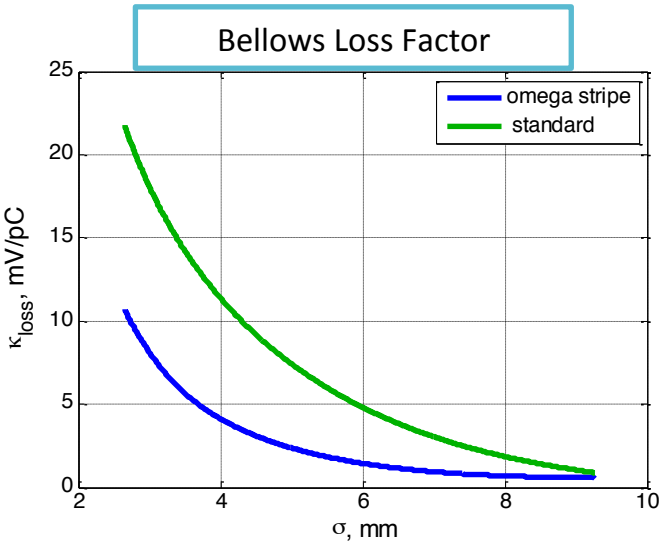
Bellows – design under study

- Built-in flanges on both sides
- Only one design
- Max. compression: 11 mm
- Max. expansion: 2 mm
- Lateral displacements will be absorbed by copper chambers.





Standard design – tapered transition

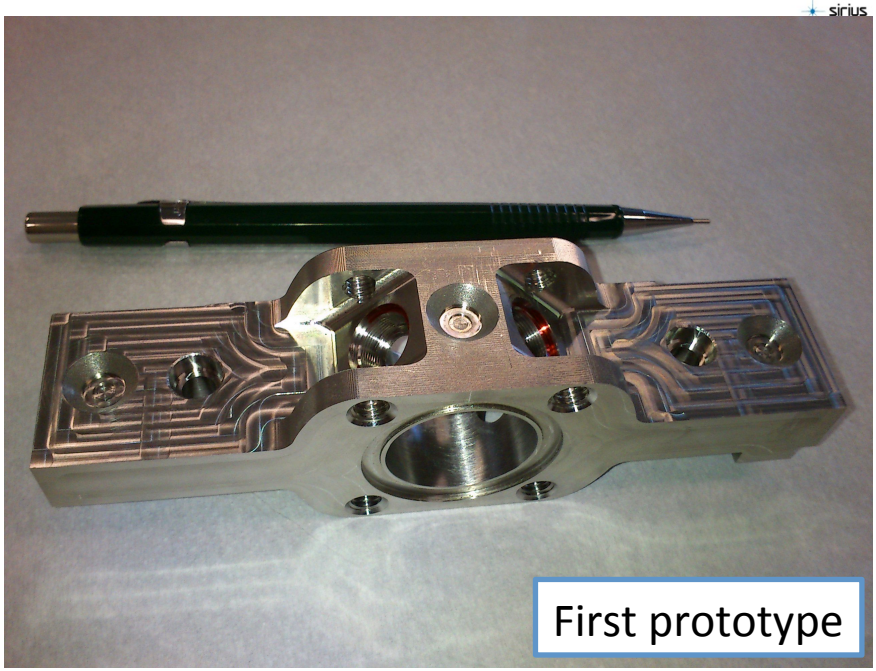


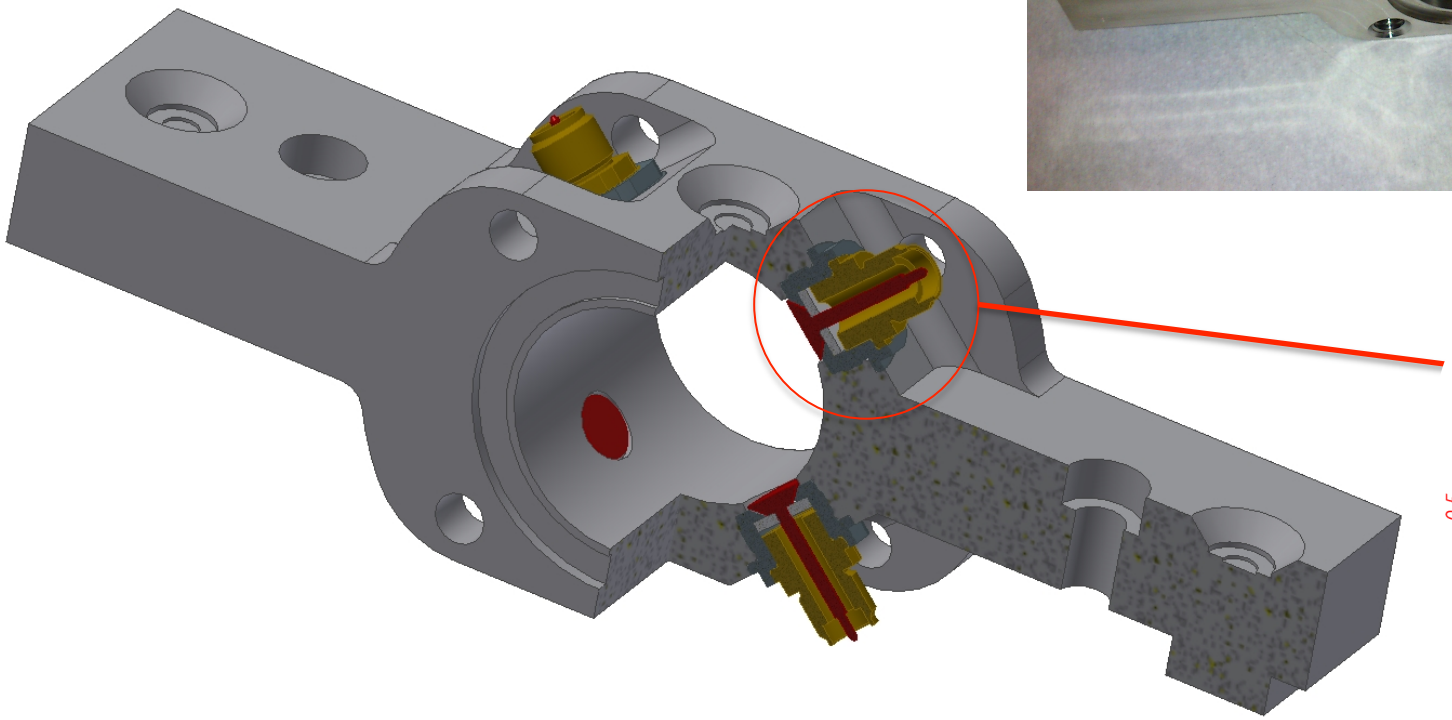
Similar to DAFNE design (omega stripe)

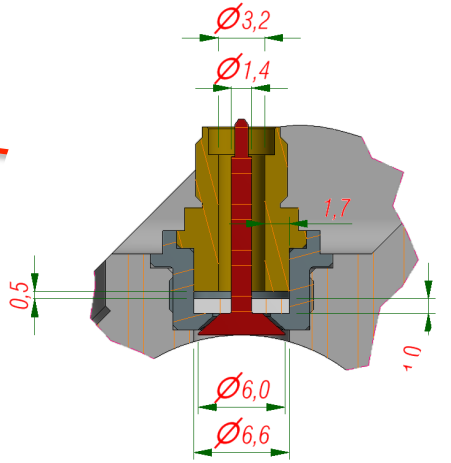
Storage ring: Chambers and components design concept

BPMs

- Stainless steel body
- Built-in flanges on both sides
- Brazed button-feedthroughs







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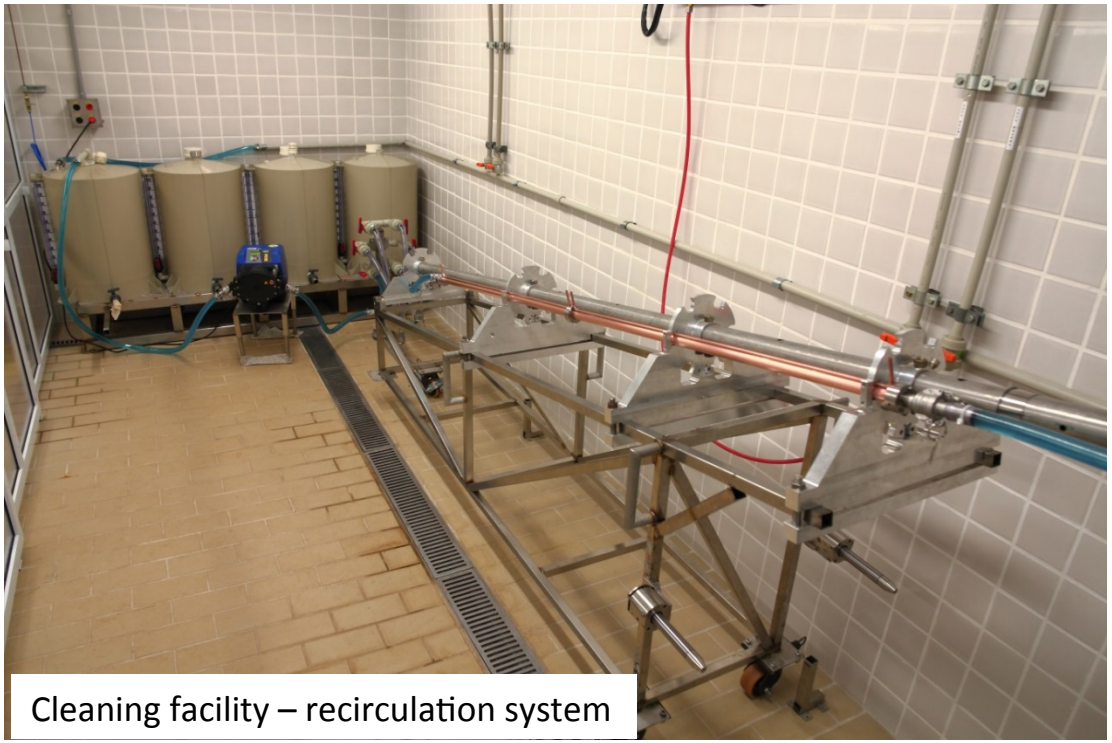
Storage ring: **Cleaning process** and NEG coating

A new cleaning procedure has been developed to avoid agressive chemicals

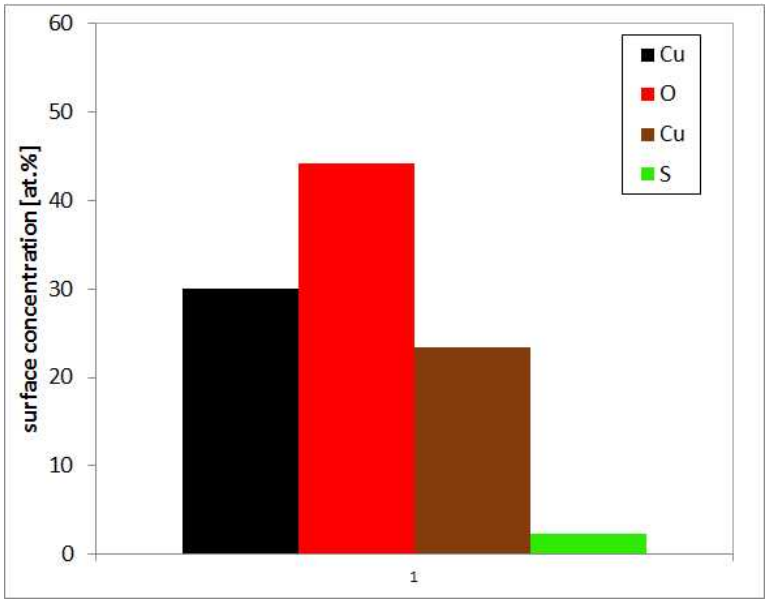
- 10% ammonium persulfate + 0,1% amonium acetate (etching ~ 15 µm)
- 5% H_2O_2 (helps to remove silver insoluble residuals)
- 5% ammonium citrate (passivation)

-- Surface roughness < 0.4 µm (Ra) --



Cleaning facility – recirculation system

XPS analysis – LNLS cleaned surface



Cleaning quality criteria:

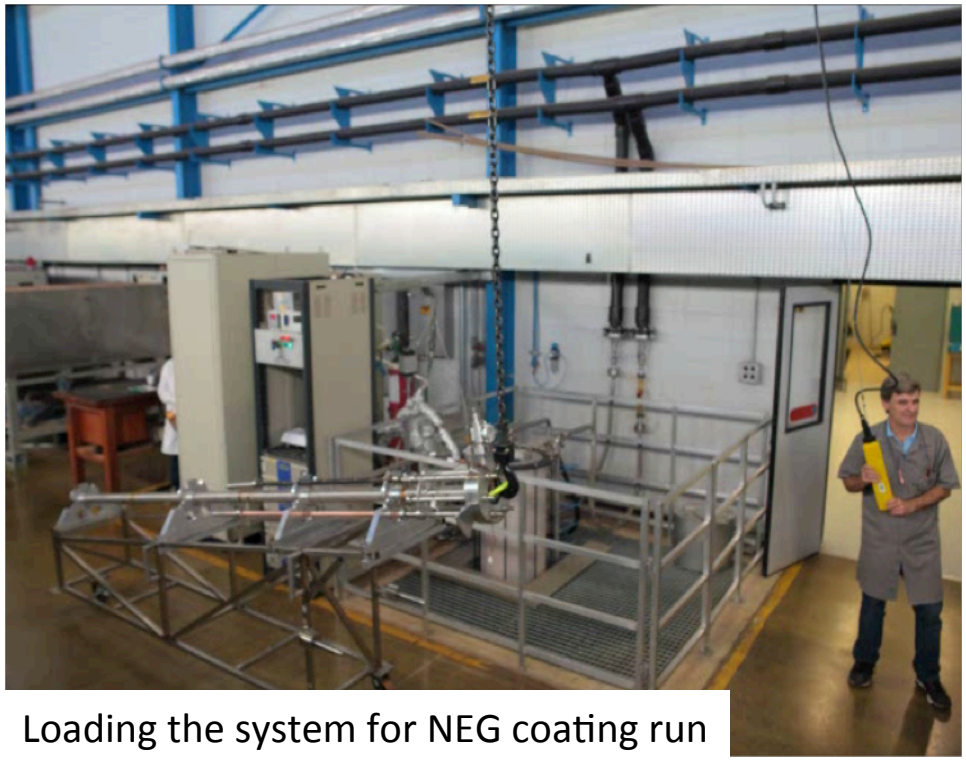
- Atomic % C < 44
- Halogens (ex. F, Cl) < 1%
- Other contaminants will be analyzed

Storage ring: Cleaning process and NEG coating

Main characteristics

- Deposition of up to 3.2 m long chambers
- Magnetic field up to 600 Gauss
- Up to 6 straight chambers simultaneously
- Bake-out system integrated to the solenoids
- Automatic control of the deposition
- Individual control of each chamber

NEG coating setup



Loading the system for NEG coating run

Storage ring: Cleaning process and NEG coating

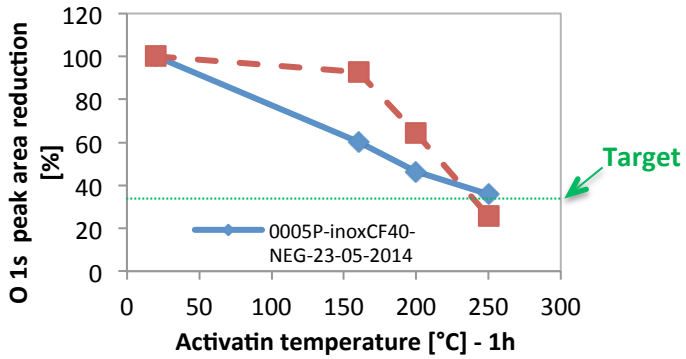
Present stage

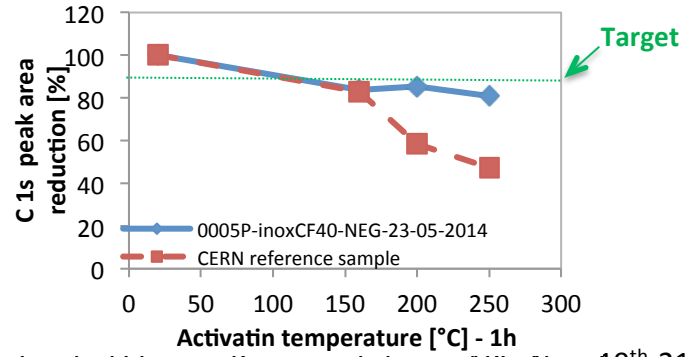
- NEG coating process optimization and studies for circular profile: straight and bent chambers

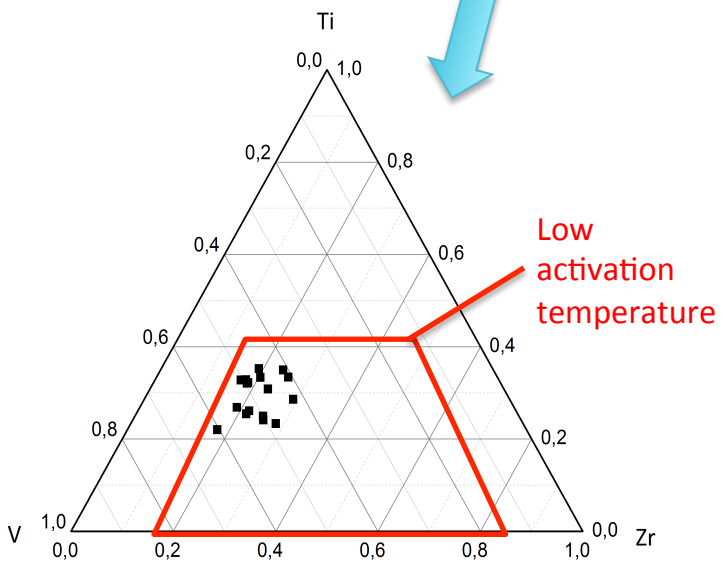
Film composition changes by varying the deposition parameters - EDS analysis

Dep name	Ti at%	V at%	Zr at%
0001P-inoxCF40-NEG-06-05-2014	26,85	54,18	18,97
0002P-inoxCF40-NEG-13-05-2014	23,32	48,32	28,36
0003P-inoxCF40-NEG-20-05-2014	26,09	52,12	21,79
0004P-inoxCF40-NEG-23-05-2014	25,45	53,04	21,51
0005P-inoxCF40-NEG-28-05-2014	24,93	50,00	25,07
0007P-inoxCF40-NEG-12-06-2014	34,96	41,06	23,98
0009P-inoxCF40-NEG-03-07-2014	33,35	46,30	20,34
0010P-inoxCF40-NEG-08-07-2014	32,07	49,58	18,35
0012P-inoxCF40-NEG-28-07-2014	32,79	50,43	16,79
0013P-inoxCF40-NEG-30-07-2014	32,83	49,42	17,75
0015P-inoxCF40-NEG-08-08-2014	32,85	49,37	17,78
0017P-inoxCF40-NEG-18-08-2014	32,19	49,28	18,53

XPS analysis – NEG film activation behavior





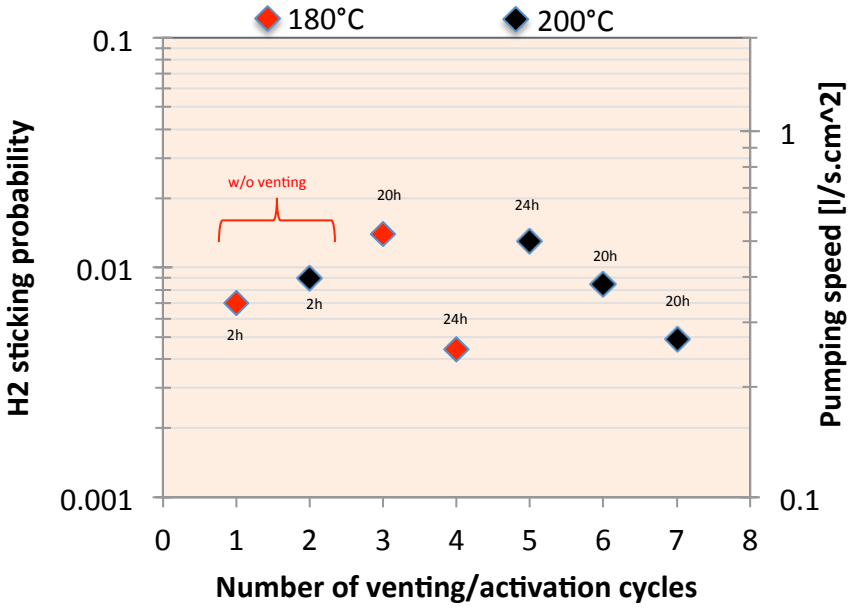


Storage ring: Cleaning process and NEG coating

NEG film studies

- Aging effect
- Photon induced desorption studies

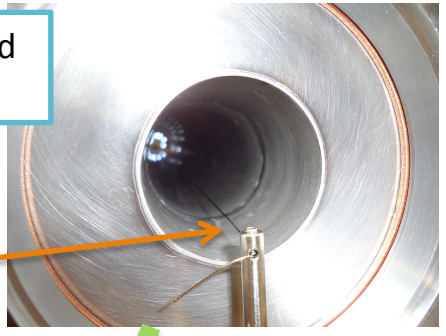
Aging effect

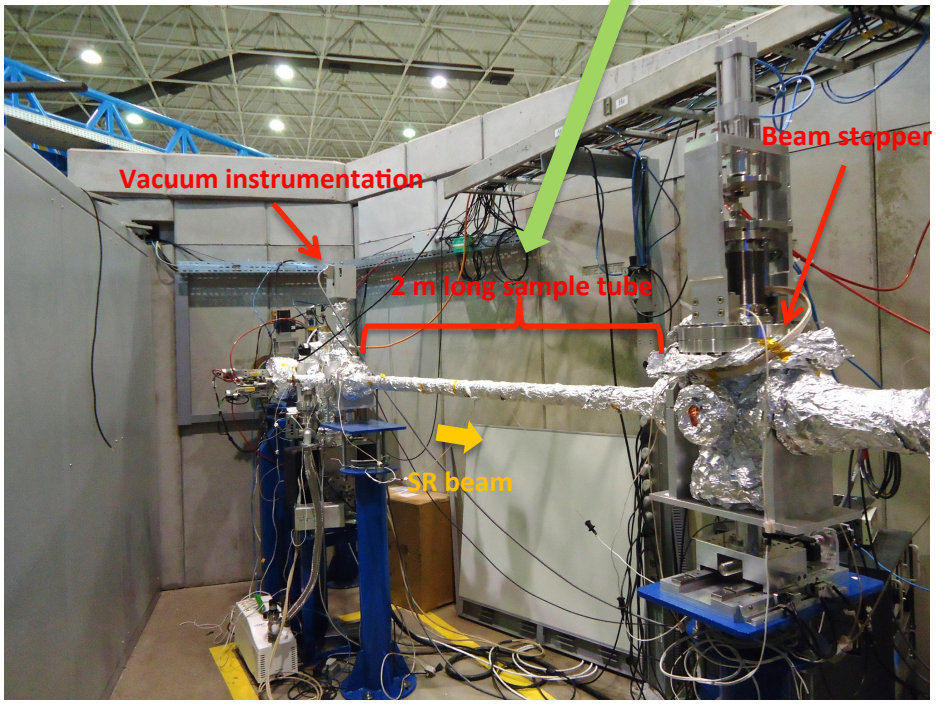


Photon desorption studies of NEG films

50 mm ID NEG coated copper tube

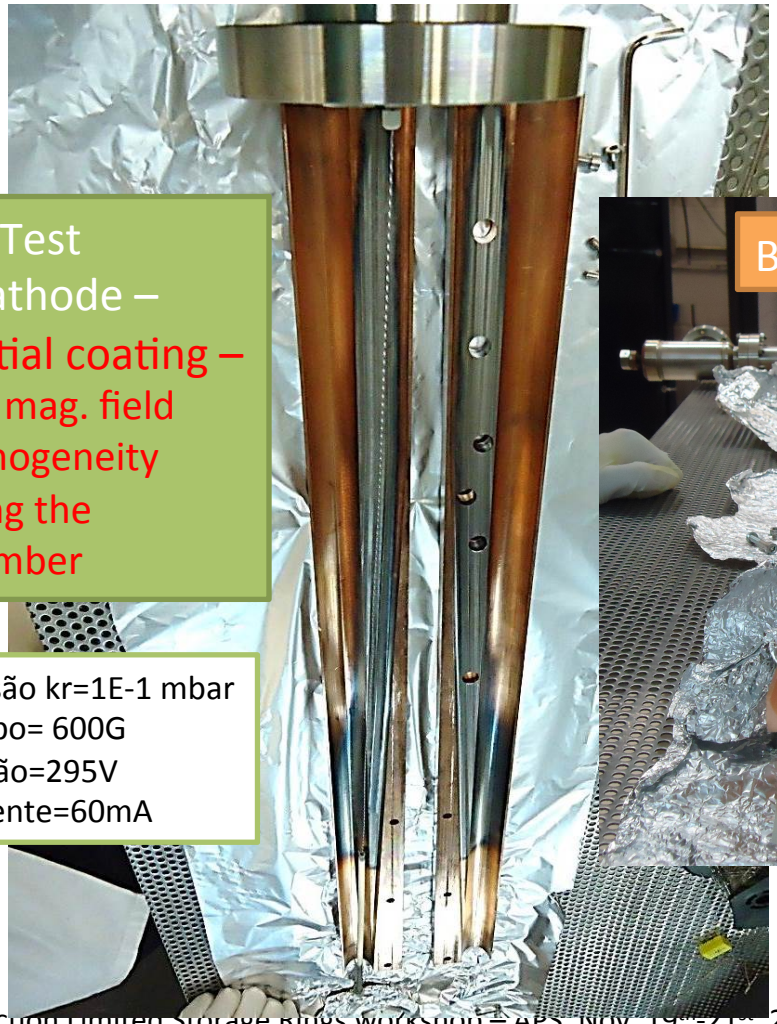
Photoelectron collector stretched along the tube





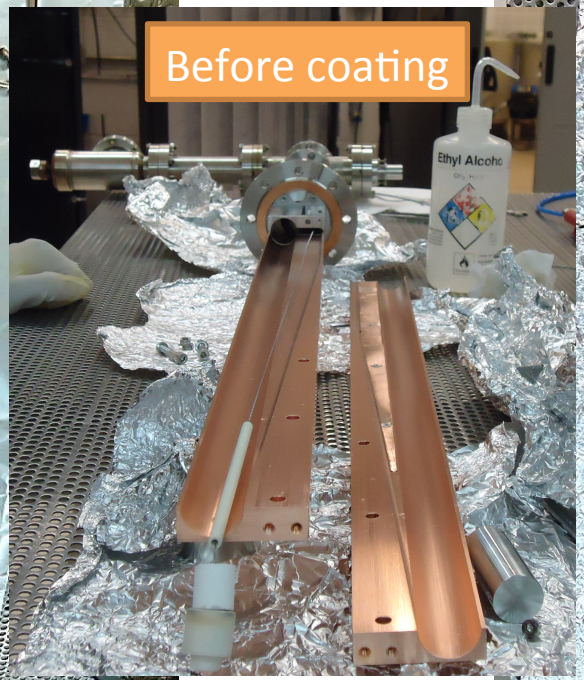
Storage ring: Cleaning process and NEG coating

Tests for NEG coating of narrow gap channels are in progress.
Prototype of dipole chamber with beam extraction channel has been cut into two halves.

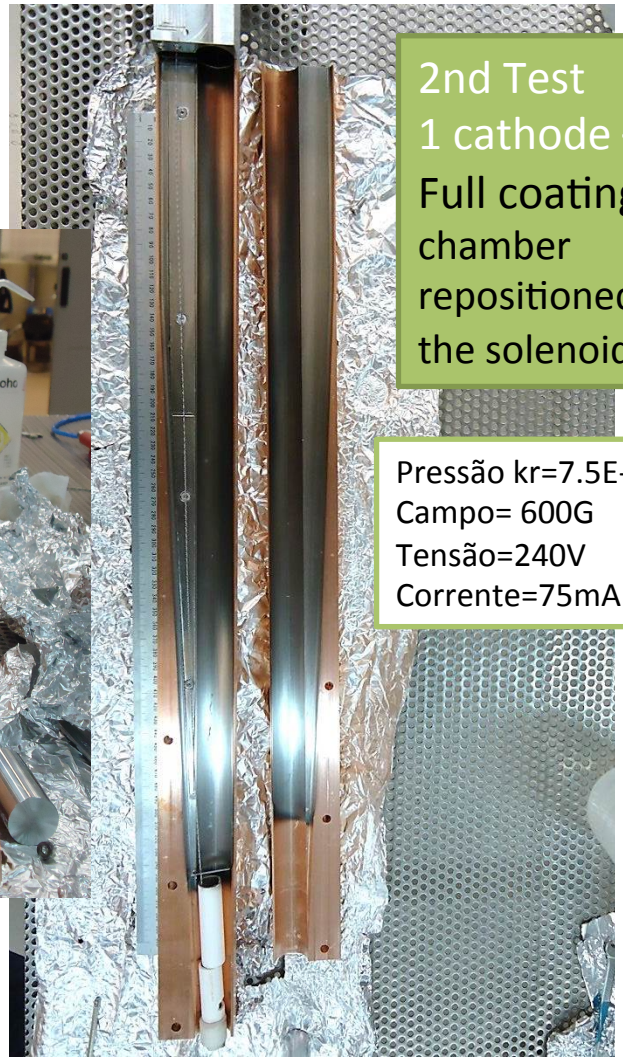


1st Test
1 cathode –
Partial coating –
bad mag. field homogeneity along the chamber

Pressão kr=1E-1 mbar
Campo= 600G
Tensão=295V
Corrente=60mA



Before coating

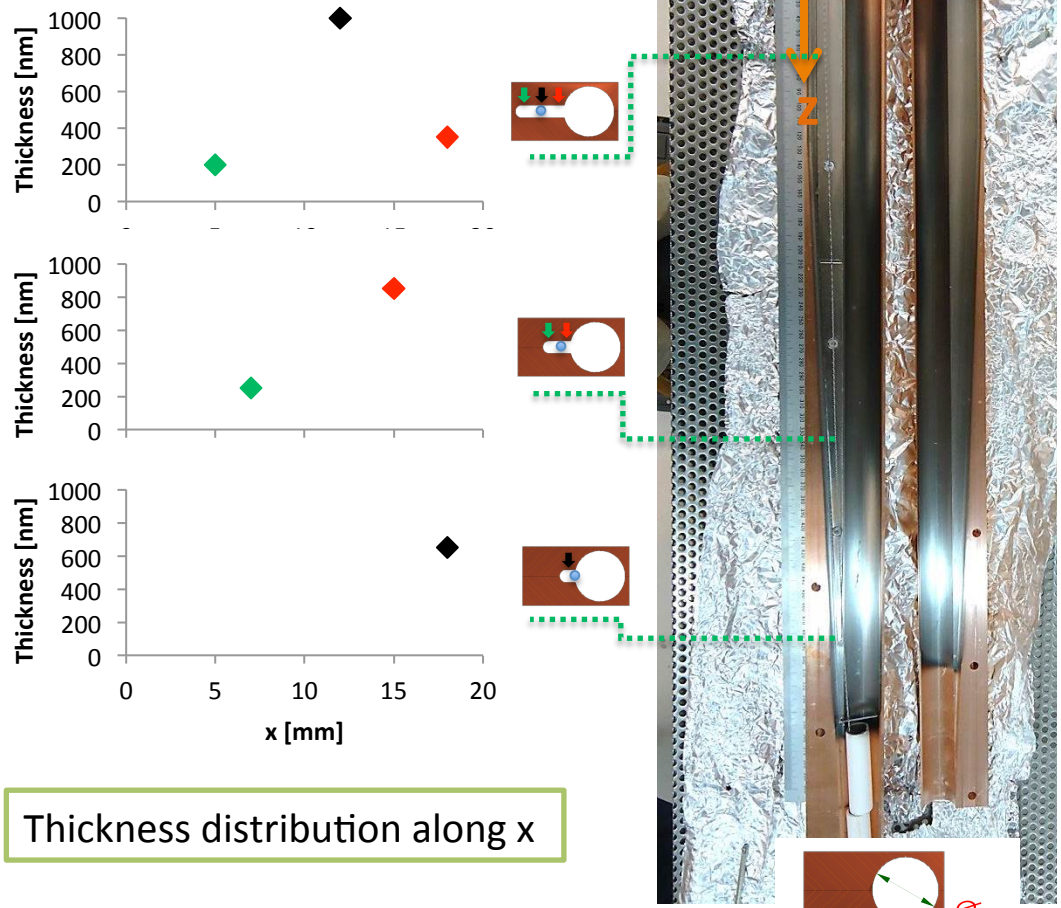


2nd Test
1 cathode –
Full coating –
chamber repositioned in the solenoids

Pressão kr=7.5E-2 mbar
Campo= 600G
Tensão=240V
Corrente=75mA

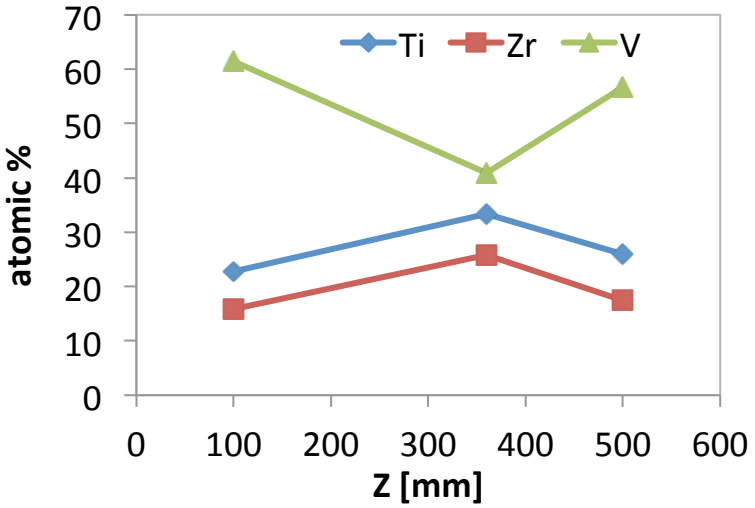
Storage ring: Cleaning process and NEG coating

Narrow gap coating quality evaluation



Thickness distribution along x

Film composition distribution along z (EDS analysis)



- Improvements are being studied.
- Coating activation still need to be tested.

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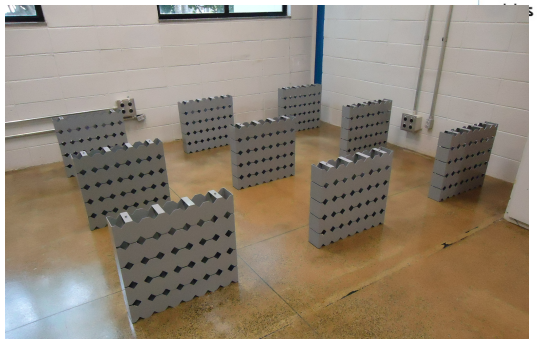
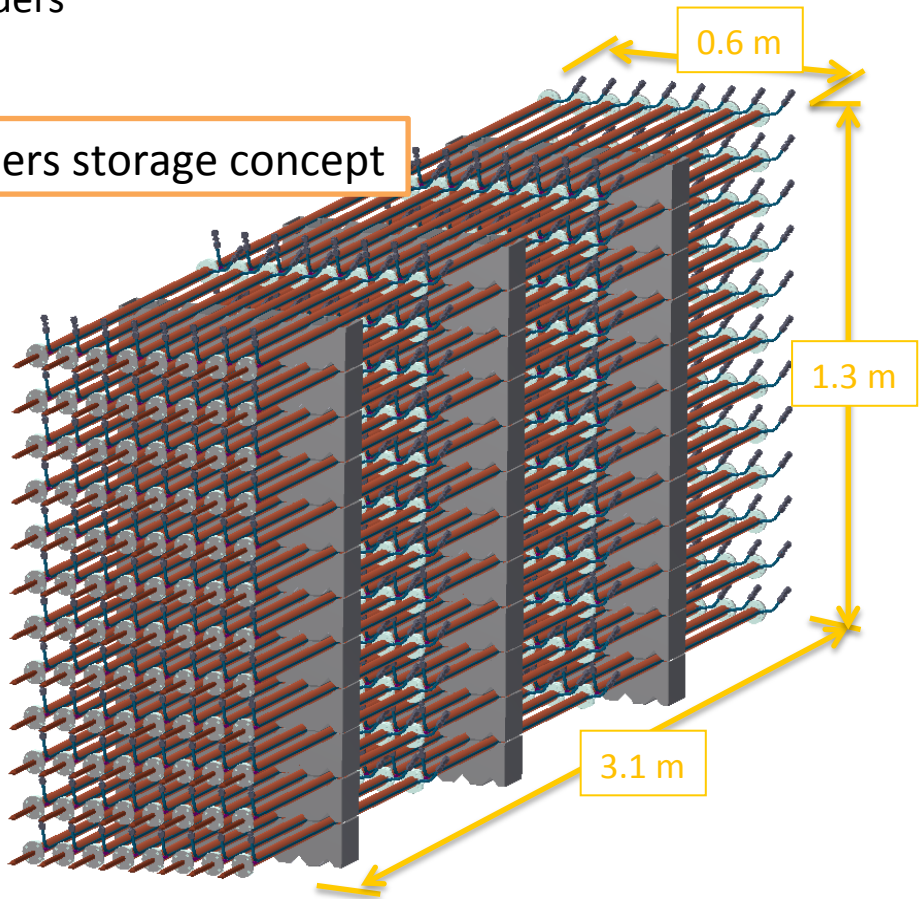
Storage ring: **Chambers storage and Installation**

1. After NEG coating, the chambers will be filled with N_2
2. The chambers will be stored in batches according to their assembly on the machine
3. The chambers will be wrapped with the heating tapes
4. The chambers will be installed in the girders
5. The chambers will be connected between girders
6. Make all electrical and hydraulic connections
7. *In-situ* bake-out for NEG activation (200 °C @ 24h)



N_2 filling and sealing

Chambers storage concept



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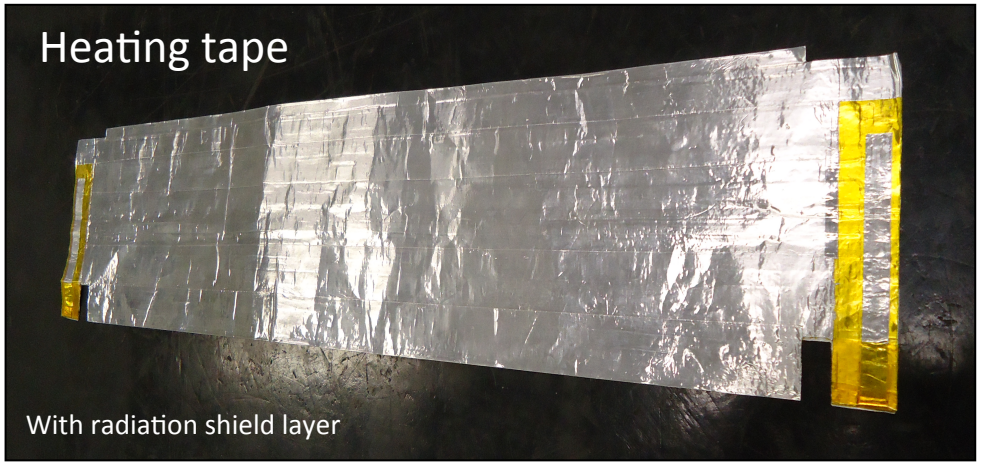
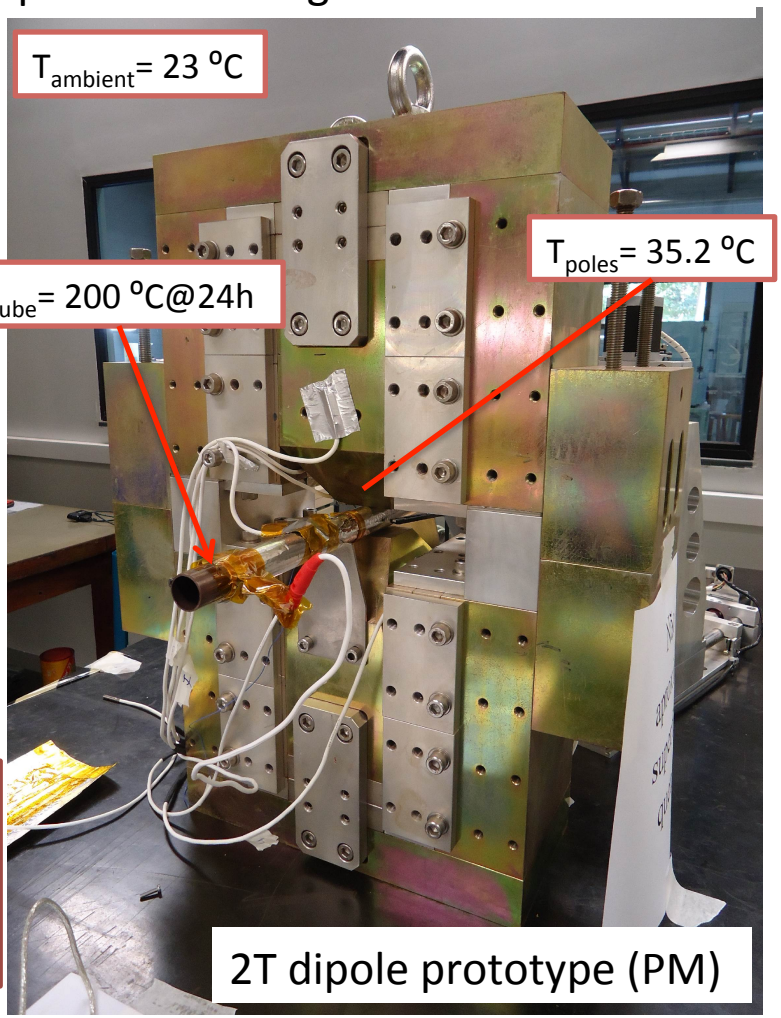
Storage ring: **Bake-out for NEG activation**

In-situ bake-out for NEG activation (200 °C@24h)
An thin polyimide heating tape (developed by a Brazilian company) is used.

- Thickness < 0.4 mm
- Max. operation temperature 210 °C



Impact of in-situ NEG activation on permanent magnets.



Magnet heating results

ΔT_{poles} = 12.2 °C

ΔT_{PM} = 8.8 °C

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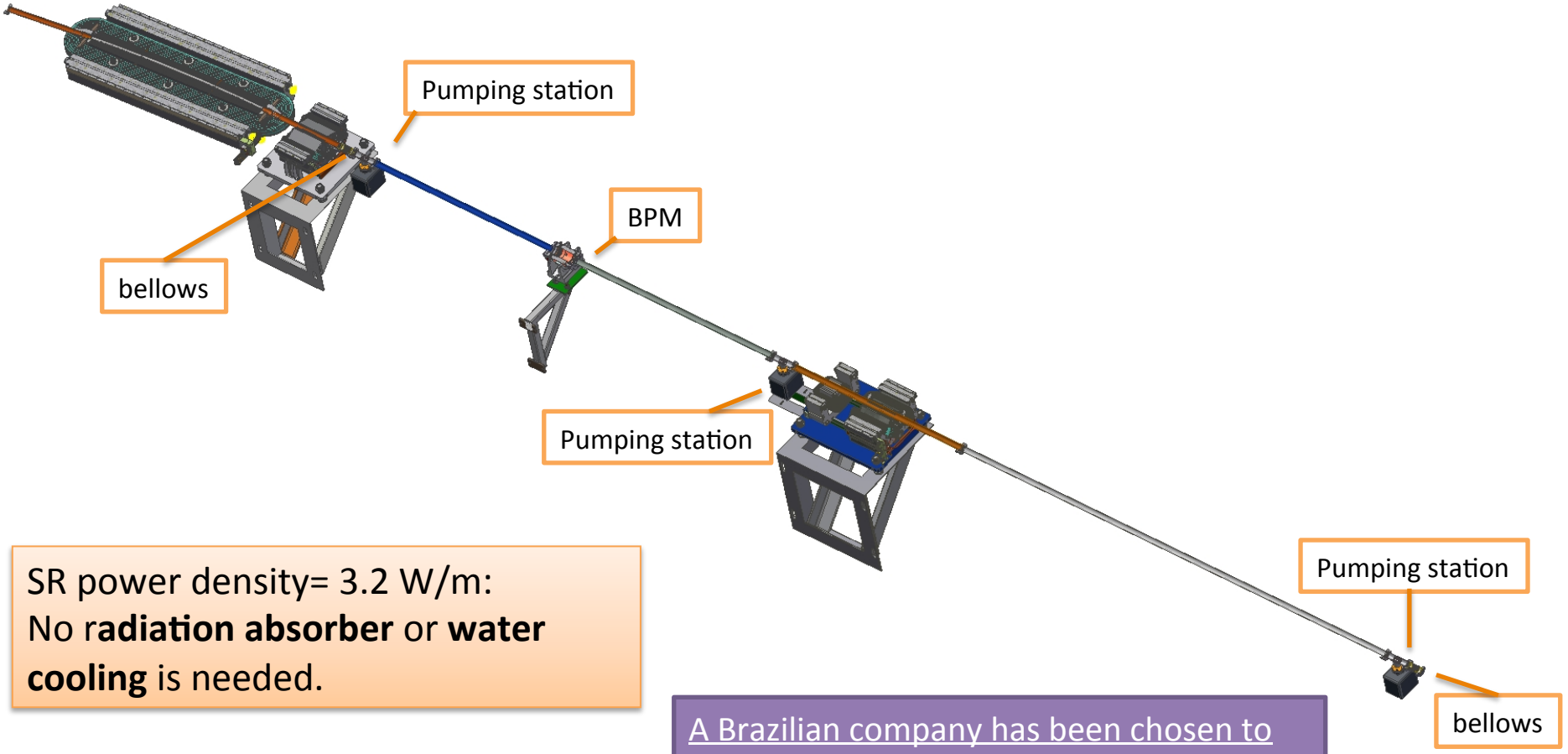
Booster

- **Material:** Stainless steel
- Circular profile chambers with dimensions of Ø36.1 x 1 *mm (*straights*)* and Ø23.4 x 1 mm (*dipoles*)



SR power density= 3.2 W/m:
No r**adiation absorber** or **water cooling** is needed.

A Brazilian company has been chosen to supply the chambers

- The dipole chambers manufacturing has been started

Thank you for your attention!